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ELECTROCHEMICAL TREATMENT OF SEED WHEAT.[1]

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ELECTRICAL TREATMENT OF CROPS.

Methods for increasing the yield of crops through the use of atmospheric or artificially generated electricity have received the attention of investigators over a long period of years. These methods usually involve considerable equipment and expense and so far have not become popular in growing general farm crops. The shortage of food, particularly wheat, caused by the World War undoubtedly aided in popularizing a method which, if found to be beneficial in results as measured by increased yields, would be of practical value in farming. This treatment consisted in subjecting the seeds of crops, the small grains especially, to an electric current passing through a conducting solution in which the seed is immersed. This process was patented and brought into use in England in 1917 by De Wolf and Fry, under the trade name "Wolfryn Electrochemical Process." The process was well advertised in England, and later in Canada, the United States, and Australia.

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[1] The treatment of wheat seed described in this circular, consisting of passing a current of electricity through a solution of common salt (other compounds have also been suggested) in which the seed was immersed, has been claimed to result in largely increased yields. Experiments made in several countries do not bear out these claims. The experiments reported in this paper, made at the Arlington Experiment Farm, show no benefit or profit resulting from treating wheat seed electrochemically. Grain yields from seed treated in this way averaged 1.1 bushels per acre less than those from untreated seed.

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PREVIOUS INVESTIGATIONS.

Treating seed by subjecting it to a current of electricity appears to have been developed in Australia several years before the Wolfryn process was given publicity. Mackinnon (*3*)[2] and Cherry (*1*), in reviews of the effect of electricity upon plant growth, mention that Butterfield and Barclay had experimented during several seasons in South Australia with electrically treated seed. Barclay was said to have increased his yield on 60 acres by fully 40 per cent by immersing the seed in a copper-sulphate solution as a conducting medium and subjecting it to an electric current for three to five minutes with an ordinary medical coil. His later results have not been made available. Similar experiments were conducted at Hawkesbury Agricultural College, New South Wales.

Mercier (*5*), in a book on the electrification of seeds and in popular articles (*4*), reviews the results of Fry in Dorsetshire, Salisbury Plain, and Cheshire and states that "in the case of cereals, substantial increase in the crop has followed the electrochemical treatment in much more than 80 per cent of the cases in which it has been fairly tried" and that "the quantity or bulk of the grain is increased . . ., the quality of the grain is improved . . ., and the straw is increased in length, in weight, and in stoutness." The electrochemical treatment, according to these reports, increased the yield 20 to 30 per cent and reduced the losses from bunt, rust, and wireworms. No really critical experimental results are reported as the basis of these claims, and ingenious but unconvincing explanations are offered to account for failures.

Russell (*7*) reports the results obtained in pot experiments with electrically treated seed at Rothamsted in 1918 and 1919. No advantage for seed so treated is shown when the weights of grain and straw from all pots growing each crop are summarized. In fact, electrically treated seed of barley and wheat yielded slightly less grain and straw than untreated seed, while treated seed of oats yielded slightly more grain and slightly less straw. In pot experiments with wheat at Oxford electrically treated seed yielded about 12 per cent more grain and slightly less straw than untreated seed. The results of Robb at the Agricultural College of Wye in a field experiment are reported by Russell. The data in Table 1 show the yield of salable grain in bushels per acre.

TABLE 1.—*Data obtained by Robb at the agricultural college of Wye in experiments with seed barley and oats treated electrochemically.*

Crop.	Yields per acre (bushels).	
	Untreated.	Electrically treated.
Barley	35.75	34.75
Oats (Abundance)	38.12	36.75
Oats (Black Tartarian)	33.00	34.75

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[2] Serial numbers (italic) in parentheses refer to "Literature cited," at the end of this circular.

The only noticeable difference between the treated and untreated plats was a more rapid germination in the treated plats of oats and barley, but this advantage soon disappeared. Two other trials with barley conducted or supervised by Cambridge University showed no increase in yield from treated seed. Russell further relates the results of weighings of wheat, barley, and oats on farms in Dorsetshire in 1918 under competent supervision. Out of seven cases, six showed gains of 8 to 61 per cent in grain yield, but no stress is placed on these results on account of the lack of uniformity of the land and because cases were rejected where there were indications of soil or crop irregularities. The 1919 reliable farm weighings of wheat, oats, and barley showed three with no difference, one with a small gain, two with distinct gains, and one with a distinct loss. Russell concludes that the electrolytic treatment lacks certainty and that "the farmer should look upon it as an adventure which may or may not prove profitable."

Rae (*6*) also reviews the work done in England and Australia on the electrochemical treatment of seed, which he states indicates that it is in this direction that we may expect the most practical developments (in electroculture) to take place.

Shutt (*8*) gives data covering one year (Table 2) obtained at Ottawa when the seed of Marquis wheat was treated by the electrochemical process. Single seventh-acre plats of each treatment were grown. The duration of the immersion of the seed in the solution was 2½ hours in each case. The statement is made that soil variation or weed growth possibly caused the decreased yield in plat 4.

TABLE 2.—*Data obtained by Shutt in Ontario in an experiment with Marquis seed wheat treated electrochemically.*

Plat.	Treatment.	Date of seeding.	Date of harvesting.	Yields per acre.	
				Grain.	Straw.
				Bushels.	*Pounds.*
No. 1....	Untreated	May 16	Aug. 15	14.23	2,506
No. 2....	Immersed in water	...do....	...do....	14.00	2,730
No. 3....	Immersed in a 10 per cent solution of sodium chlorid.	...do....	...do....	13.41	2,590
No. 4....	Immersed in a 10 per cent solution of sodium chlorid and subjected to direct electric current (total volume of solution 40 gallons, one-third kilowatt hour)	...do....	...do....	11.55	2,842

Lee (*2*), working at the Manitoba Agricultural College, presents the data shown in Table 3 on a single-plat test with Marquis wheat.

TABLE 3.—*Data obtained by Lee in Manitoba in an experiment with Marquis seed wheat treated electrochemically.*

Treatment.	Date of seeding.	Date of ripening.	Date of cutting.	Yields per acre.	
				Grain.	Straw.
				Bushels.	*Pounds.*
Untreated	May 12..	July 30 to Aug. 6..	Aug. 8..	14.5	4,266
Electrically treated	...do.....	July 31 to Aug. 6..	...do.....	18.0	4,800

Biffen[3] writes: "The trials we made here show no improvement in yield as the results of the treatment . . . . The treatment resulted in a small diminution of the germinating capacity." The treatment of the seed in this case was applied by Fry, one of the patentees of the process.

EXPERIMENTS AT THE ARLINGTON EXPERIMENT FARM.

In the fall of 1920 experiments were begun at the Arlington Experiment Farm, located in Virginia near Washington, D. C., to determine the value of the electrochemical treatment of winter wheat. A uniform lot of Purplestraw, a variety of soft red winter wheat, was divided into four lots, three of these to be used as checks. The method used for the electrochemical treatment was practically that recommended by Fry, as given by Mercier (*5*) and Russell (*7*). A 3.5 per cent solution made by dissolving about 7 pounds of common salt in 25 gallons of tap water was placed in a wooden tank 36 inches long by 18 inches wide by 21 inches deep. Sheet-iron plates to which were attached the wires carrying the electric current were immersed in the solution, one at each end of the box. The grain was presoaked for two hours in the salt solution, and then a direct current of approximately 200 watts (8 watts to 1 gallon of the solution) was passed through the conducting solution for 3½ hours. As checks against the electrochemical treatment, a second lot of the original seed was immersed in a duplicate salt solution for 5½ hours, but without the electricity, and a third lot was soaked in tap water for an equal time. After treatment the grain was allowed to drain, and then was spread on a bench in a warm greenhouse to dry, all three lots being handled alike. Two days later, on November 1, seedings were made in fortieth-acre plats (132 by 8¼ feet), replicated as shown in Table 4, from these three seed lots and also of untreated original seed. All immersed lots, being slightly swollen, were sown at the rate of 7 pecks per acre, thus being made comparable in number of seeds per acre with the 6-peck rate of seeding employed for the dry-seed check.

The method used in 1921 was similar in principle to that of the preceding year in so far as the nature of the conducting solution and the electrical energy used are concerned. Instead of the wooden tank a stone sink 27 inches long by 17 inches wide by 16 inches deep was employed for treating, and following the treatments all immersed seed was dried in the greenhouse for a period of five days, when it was again normal in size and moisture content. The rate of seeding for all plats was 6 pecks per acre in 1921, and seedings were made on October 13. An ordinary single-disk grain drill, which spaced the rows 8 inches apart, was used in both 1920 and 1921. The soil used for the experiments is classed as Keyport silt loam.

In 1920 germination tests were made on duplicate samples of 100 kernels each of the treated seed as sown. After three days the counts showed germinated kernels in the three lots as follows: Water-soaked, 88 per cent; electrically treated, 84 per cent; and salt solution, 74 per cent. After nine days the counts were, respectively, 89, 87, and 78.5 per cent. The radicles of the germinated kernels of the seed treated with the salt solution were shorter than in the other lots, and a distinct delaying and reduction of germination were evident. Delayed germination and reduced vigor in the plats sown with this lot of seed also were evident for some time after sowing in the fall of 1920. In the 1921 sowings, however, the stand of all plats appeared uniform.

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[3] Biffen, R. H. Letter to Dr. C. R. Ball dated March 21, 1922.

In both years the later field growth of the plants in the plats sown with the four lots of seed was not noticeably different, either in vigor or in dates of heading and ripening. Leaf rust (*Puccinia triticina*) was severe in both 1921 and 1922, all plats being equally affected so far as could be observed. Other diseases were not present in any of the plats to an appreciable extent. More or less lodging also occurred, but it could not be correlated with seed treatment, although it may have influenced the yield slightly and the quality of the grain in some cases. Plats grown from electrochemically treated and untreated seed are shown in Figure 1.

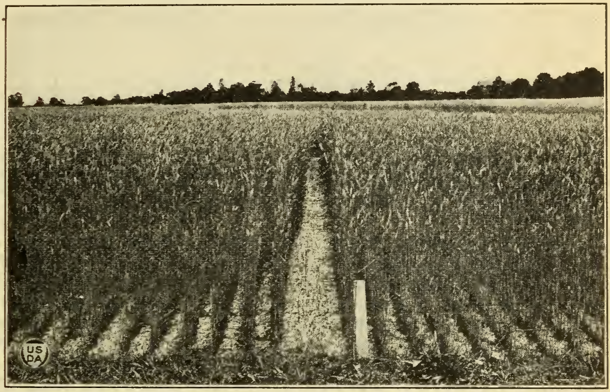

FIG. 1.—Wheat plats on the Arlington Experiment Farm, 1922. Purplestraw wheat grown from untreated seed (on the left); from seed treated electrochemically (on the right).

The acre yields of grain and straw and the weight per bushel of the grain from the plats for the two-year period are presented in Table 4. The yields when read from left to right appear in the order of the replicated fortieth-acre plats as grown in the field. In seven out of eight cases the dry-seed check plat outyielded the plat next to it sown with electrochemically treated seed. The one exception, in 1922, showed a gain of two-fifths bushel for the treatment over the dry-seed check. The mean difference in grain yield between the eight untreated-seed plats and the eight adjoining electrochemically treated seed plats, grown in the two years, is 1.7 bushels per acre in favor of the untreated seed. The odds[4] are 96 to 1 that this mean difference is significant.

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[4] Determined by "Student's" method.

TABLE 4.—*Acre yields of grain and straw based on yields obtained from fortieth-acre plats of winter wheat sown with seed treated electrochemically as compared with check treatments at the Arlington Experiment Farm in 1921 and 1922.*

Year and series.	Yields per acre and weights per bushel.											
	Check, seed unsoaked.			Treated electrochemically.			Treated, salt solution.			Treated, water only.		
	Straw.	Grain.	Bushel weight.	Straw.	Grain.	Bushel weight.	Straw.	Grain.	Bushel weight.	Straw.	Grain.	Bushel weight.
1921:	*Lbs.*	*Bu.*	*Lbs.*	*Lbs.*	*Bu.*	*Lbs*	*Lbs.*	*Bu.*	*Lbs.*	*Lbs.*	*Bu.*	*Lbs.*
No. 1	4,240	28.2	60.5	4,650	26.2	57.5	3,920	25.1	60.0	4,260	27.3	60.5
No. 2	4,040	28.7	62.0	3,820	24.7	61.0	3,710	23.8	62.5	2,860	24.7	62.0
No. 3	3,840	24.9	60.5	3,770	21.2	61.0	3,740	16.3	60.5	3,800	21.6	61.0
No. 4	3,820	21.2	61.5	......	......	......	......	......	......	......	......	......
Average	3,985	25.8	61.1	4,080	24.0	59.8	3,790	21.7	61.0	3,640	24.5	61.2
1922:												
No. 1	3,940	35.7	61.5	3,540	33.3	61.0	3,100	29.0	62.0	3,380	30.3	61.5
No. 2	3,640	32.4	61.0	3,760	32.8	61.0	3,850	32.8	62.0	4,430	34.5	60.5
No. 3	4,000	33.3	61.5	4,170	32.5	59.0	3,980	28.7	56.0	4,000	27.6	59.0
No. 4	4,120	27.7	57.5	3,800	26.7	58.5	3,060	23.7	60.0	2,660	22.3	59.0
No. 5	3,070	24.1	59.5	3,170	24.0	58.5	3,370	27.1	59.0	3,060	27.3	60.5
No. 6	3,270	28.8	61.5	......	......	......	......	......	......	......	......	......
Average	3,673	30.3	60.4	3,688	29.9	59.6	3,472	28.3	59.8	3,506	28.4	60.1
2-year average	3,829	28.1	60.8	3,884	27.0	59.7	3,631	25.0	60.4	3,573	26.5	60.7

The details regarding yields and bushel weights presented in Table 4 need not be repeated here. The average of all plats grown for the two years shows that the electrochemically treated seed yielded per acre 1.1 bushels less grain and 55 pounds more straw than the dry seed. The electrochemically treated seed averaged half a bushel more grain per acre and 311 pounds more straw than the water-treated seed. The seed treated with salt solution averaged 2 bushels less grain per acre and 253 pounds less straw than the electrochemically treated seed. The bushel weight of the grain produced from electrochemically treated seed averaged 1.1 pounds less than all of the grain from dry seed; comparing only the eight adjoining plats, the mean difference for the two years is 0.8 bushel and the odds, determined as above, are only about 12 to 1 that this is significant. The grain from plats sown with seed receiving the other treatments averaged about the same as the grain from the dry-seed plats.

CONCLUSIONS.

Data obtained from replicated plats of winter wheat harvested at the Arlington Experiment Farm in 1921 and 1922 showed no benefit or profit resulting from treating the seed electrochemically by the so-called "Wolfryn" process. Grain yields from all plats sown with electrochemically treated seed averaged 1.1 bushels per acre less than yields from all plats sown with untreated seed. No effect of the treatment on plant growth or disease infection could be observed.

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